

12/2/2017

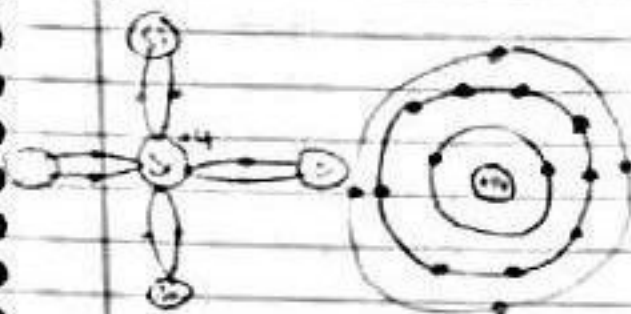
Revision

1

Types of semiconductors

Intrinsic
(pure)

Σ

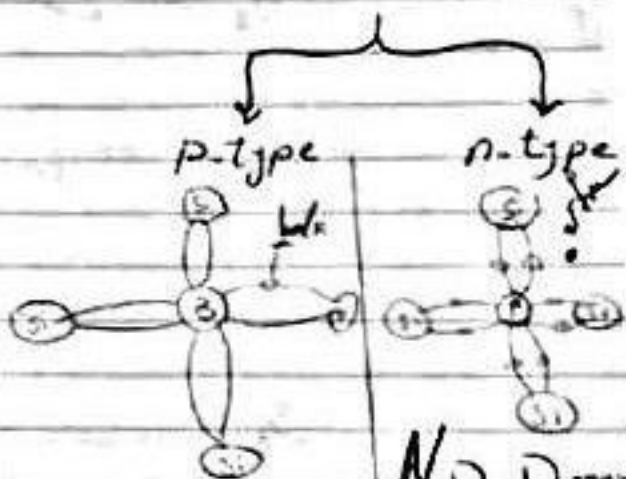


P. holes

n. electrons

$$n = p = n_i$$

Extrinsic
(By Doping)



Na⁺ ion
(B)

holes majority

electrons minority

$$p \gg n$$

ND⁻ Donor
(P) +ve ion

concentration
of electrons
(majority)

p. conc.
of holes
(minority)

$$n \gg p$$

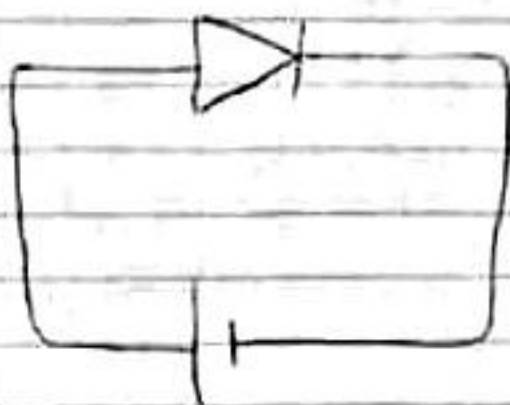
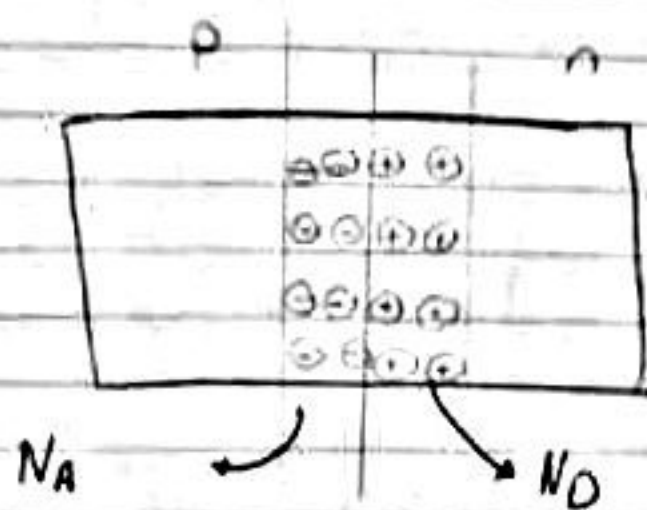
electrons, holes → mobile
ions → immobile

(2)

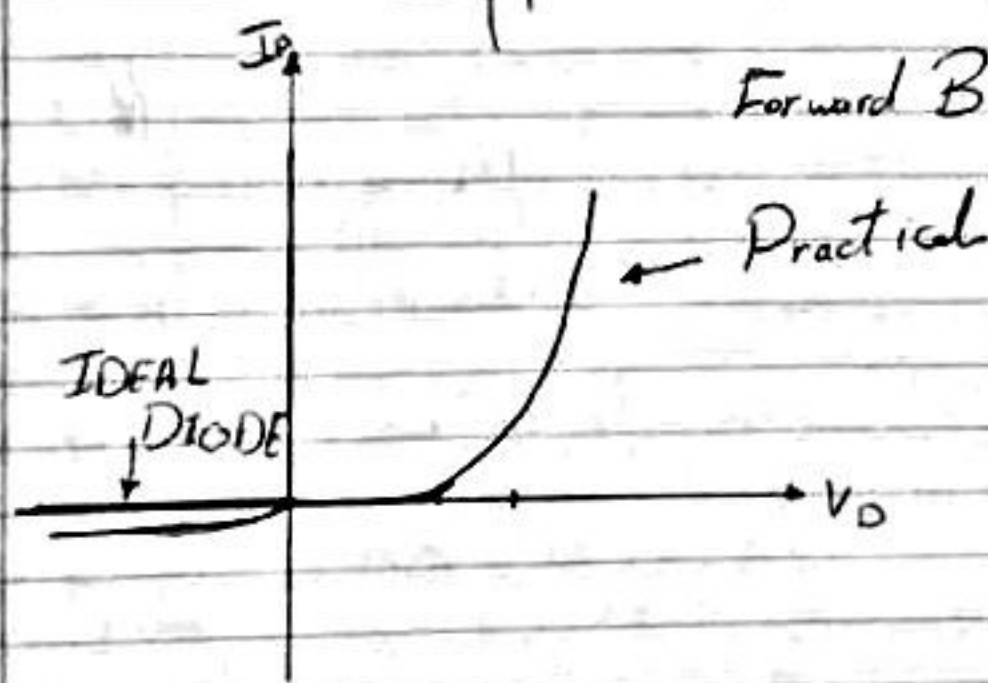
$$R, \rho, L$$

$$E = \frac{V}{d}$$

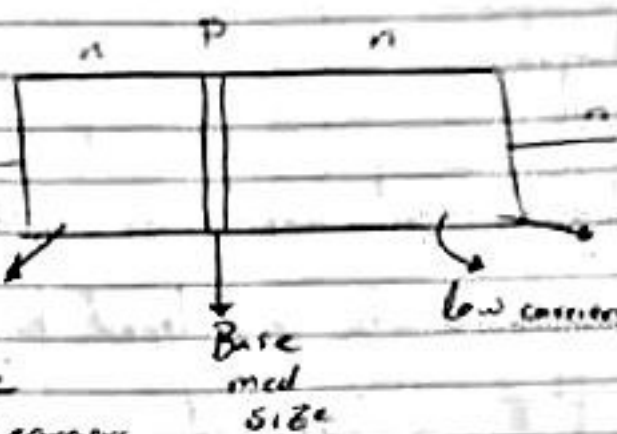
P.N Junction Diode



Forward Bias



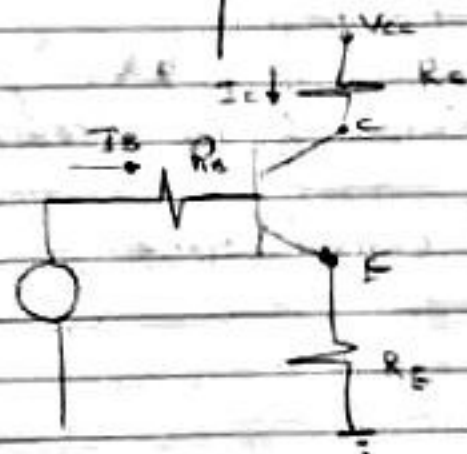
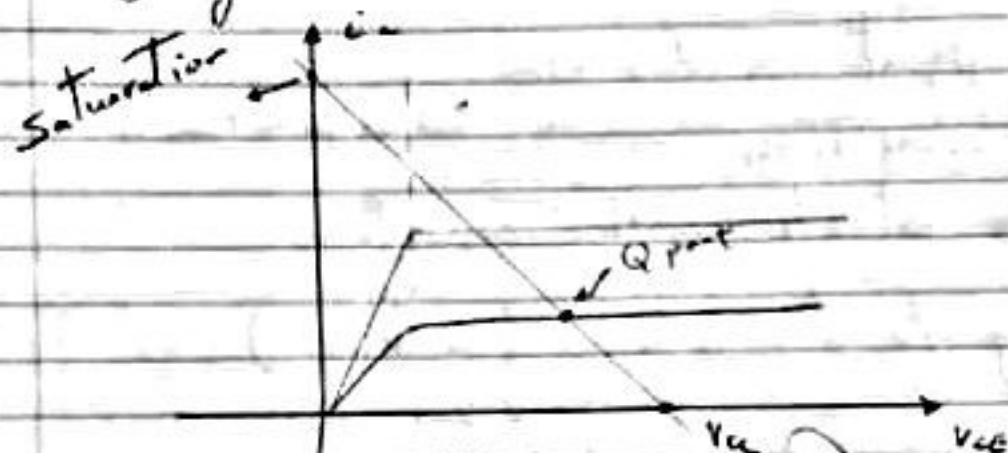
BJT



emitter
- med size
- majority carriers

collector

large
sized
to absorb
as many
electrons



$$I_{C_{KVL}} = \frac{V_{CC} - V_{CE}}{R_B + R_C}$$

KVL

$$I_C = \beta I_B$$

FET

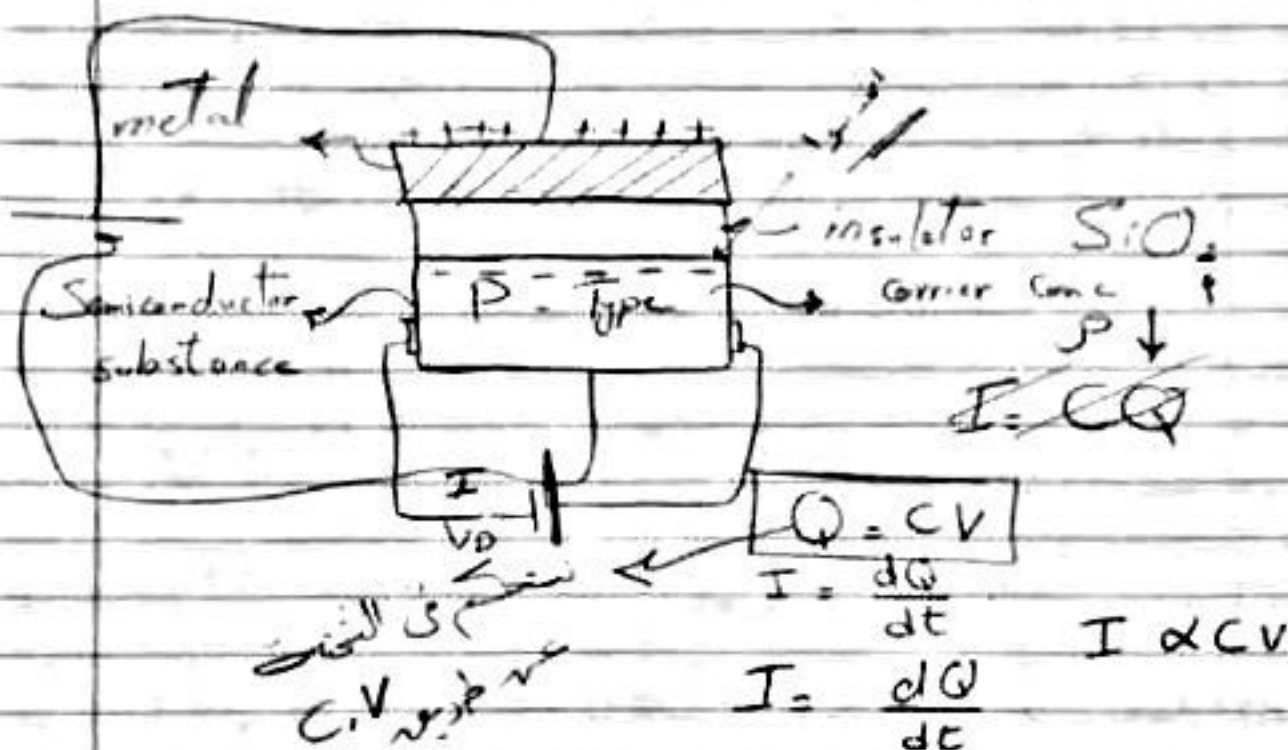
Junction FET
(JFET)

MOSFET
(Metal Oxide Semiconductor FET)

Depletion

Enhancement

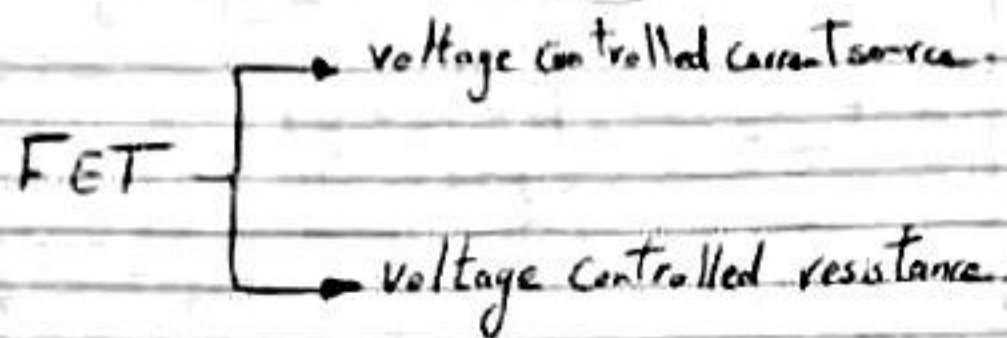
II. SFET (unipolar)



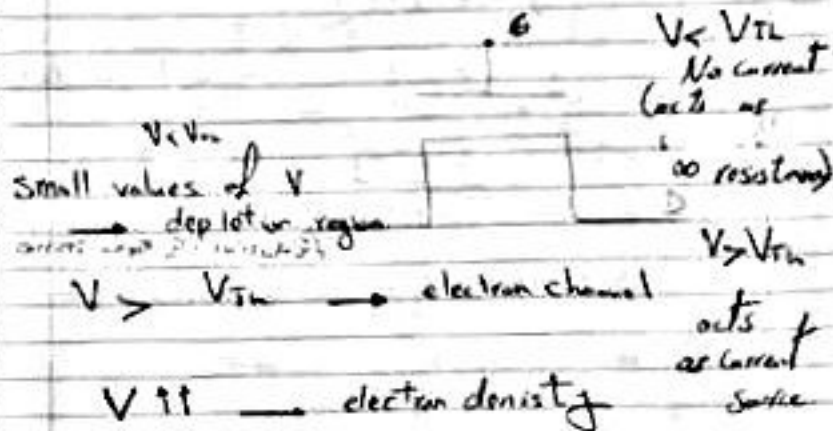
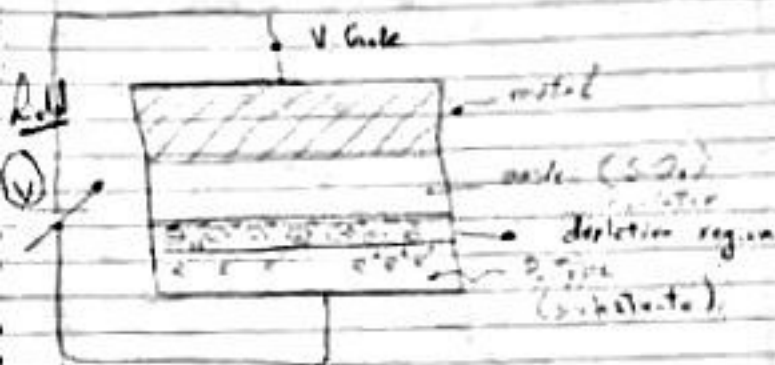
Field effect Transistor (FET)

Its advantages

1. It has high input impedance (10^9 to $10^{12} \Omega$)
 This input impedance is considered higher than BJT so FET is preferred over BJT for use as input (First stage in multi stage so less power dissipation) and as protection in ~~mobile devices~~
2. More stable with Temperature
3. Easy to Fabricate (implement)
4. Less sensitive to radiation.
5. ^{It's} Voltage controlled current ^{source} preferable than current controlled current source.

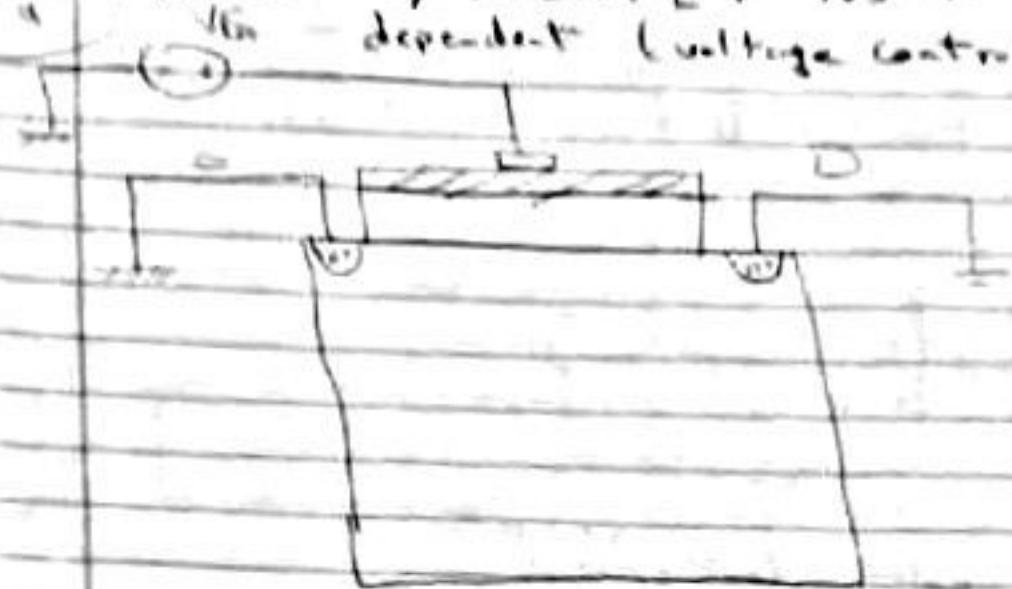


FET is used to reduce high power signals
in mobiles.



لا يستطع التيار أن يمر في القناة بطبيعة الحال فيكون هناك تيار وبالتالي لا يمكن التحكم في التيار

Operation of MOSFET As a voltage dependent (voltage controlled) Resistor



$$V_G < V_{th} \quad \text{Resistance } \infty$$

$$V_G \uparrow \quad R \downarrow$$

Q

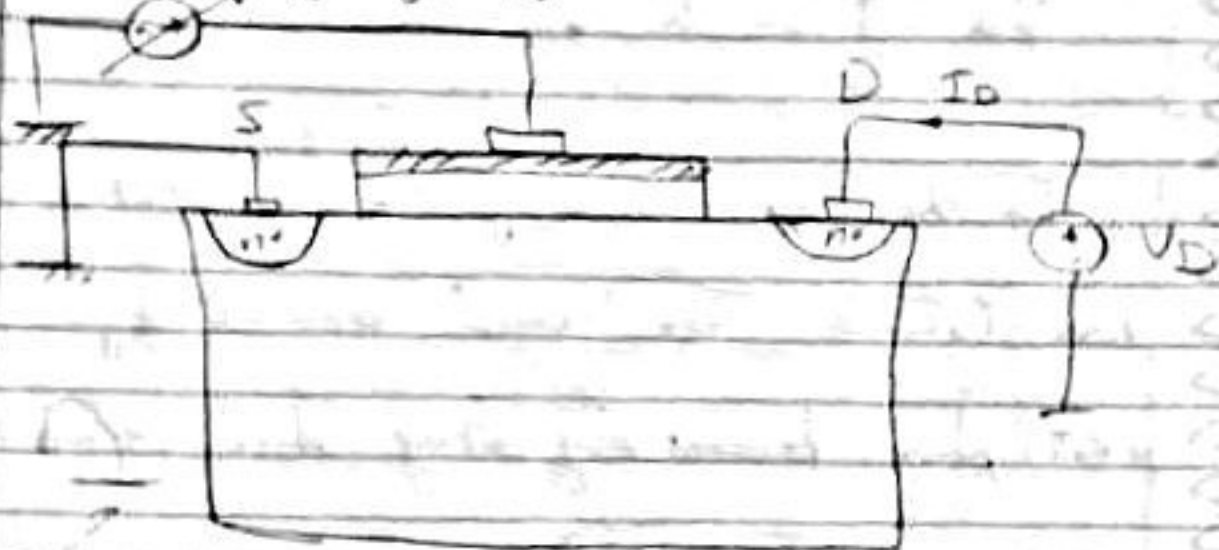
Ex... In a vicinity of a wireless base station. The signal received by a cell phone becomes very strong which prohibits proper operation. Devise a variable gain circuit that lowers the signal level the signal level as the cell phone approaches the Base station.



Work as a variable load

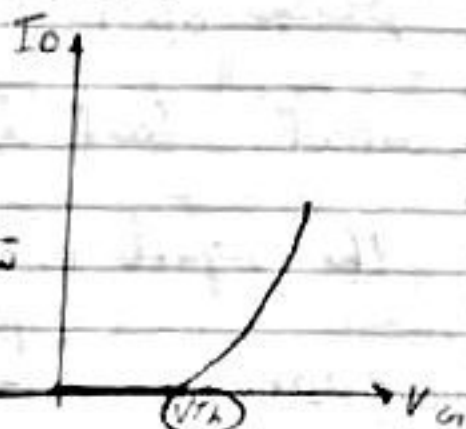
المصدر يزيد $V_{out} = V_{in} \frac{R_c}{R_i + R_c}$
 MOSFET يغير الاستدارة

استنتاج العلاقة بين (I_D, V_{DS}) و (I_D, V_G)



$V_G \uparrow R \downarrow$

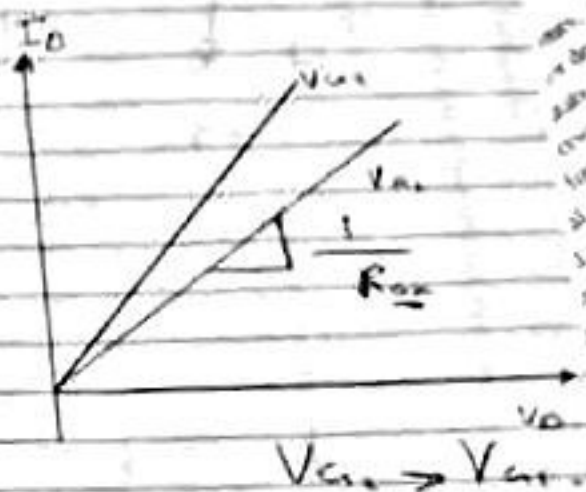
V_D ثابت



($I_D - V_D$)

V_G

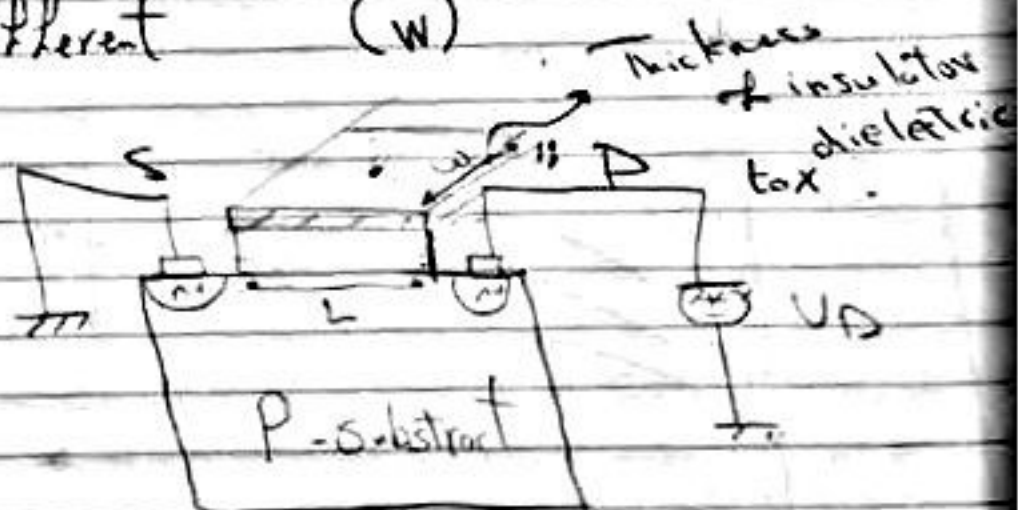
$V_G > V_{TH}$



Ex 2: Sketch $I_D - V_G$ and $I_D - V_D$ characteristics

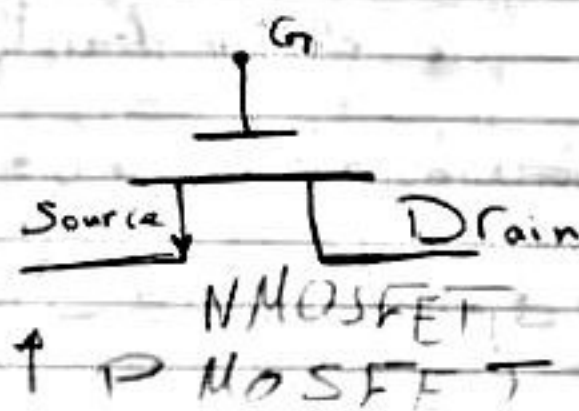
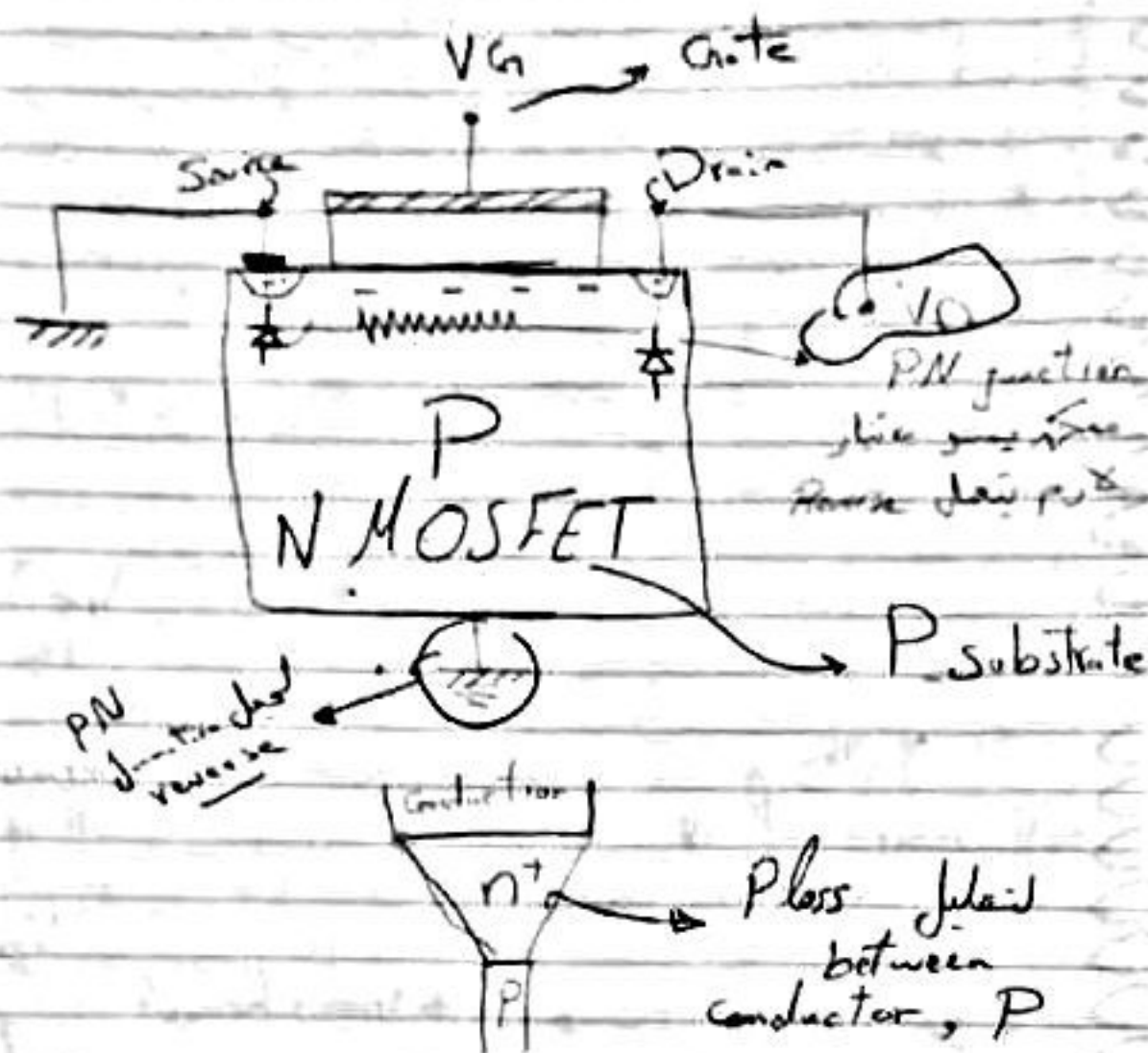
for

- (a) Different lengths.
- (b) Different ^{oxide} thickness (t_{ox})
- (c) Different (W)

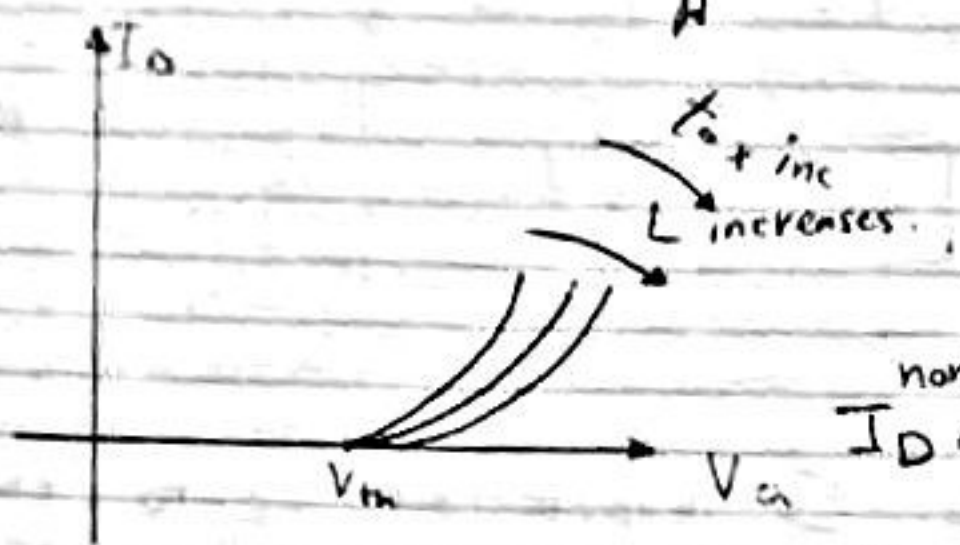


③
 NMOSFET carriers electrons

PMOSFET carriers holes



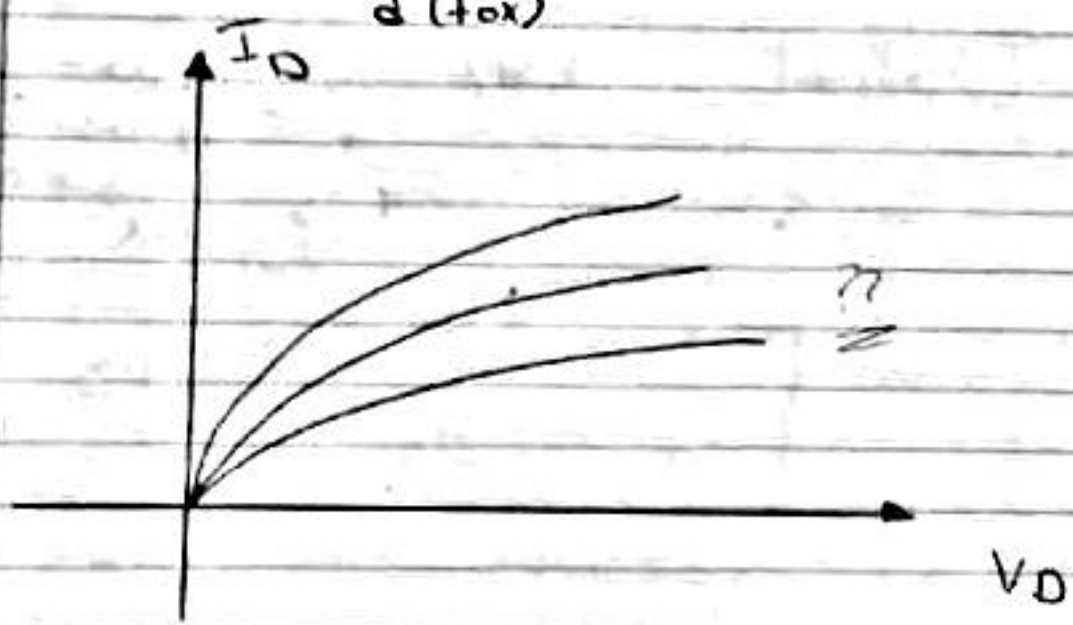
$I_D \downarrow$ as $L \uparrow$
 $R_{PL} = \frac{PL}{A}$



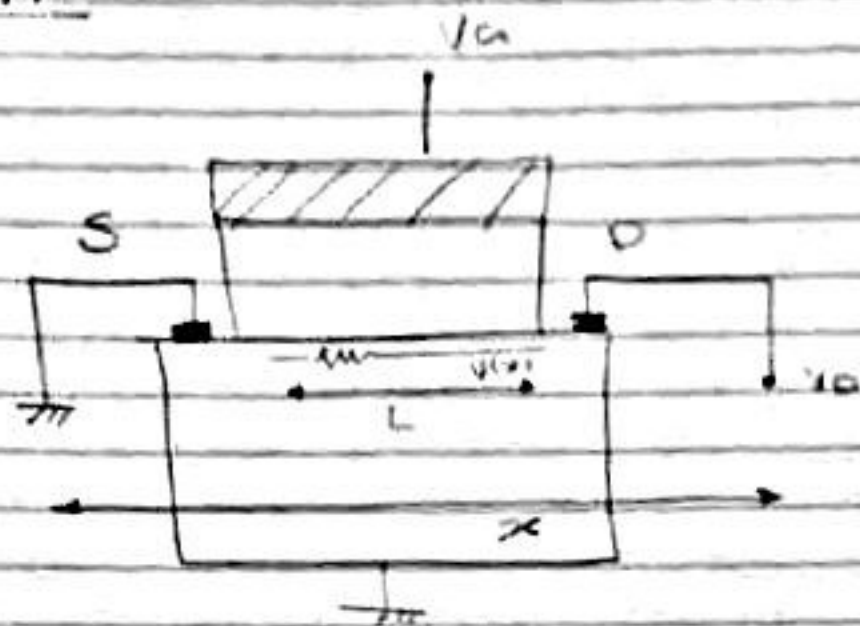
non linear
 $I_D \propto \frac{1}{L}$
 $I_D \propto \frac{1}{t_{ox}}$

$$Q = CV$$

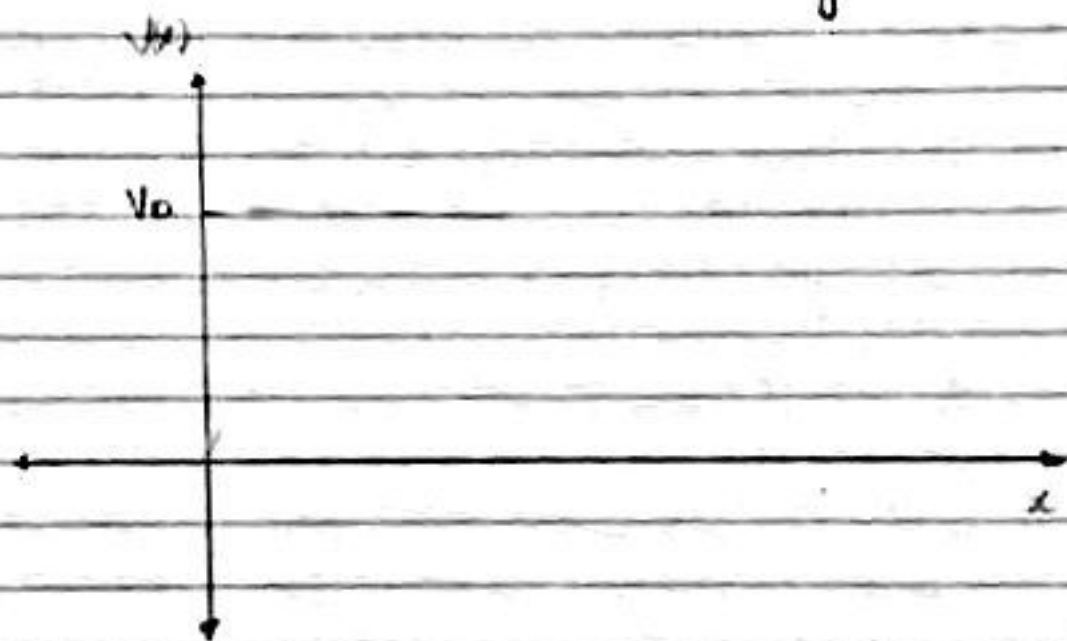
$$C = \frac{\epsilon A}{d(t_{ox})} \quad A = wl$$



Pinch off



$V(x)$ $\rightarrow x$ graph



2nd term

Circuit 2

12.12.2018

Content:

First order system

Second order system

1) Transient analysis (RL, RC) RLC

2) Mutual inductance circuits
Magnetically coupled coils.

3) Three-phase circuits.

4) Operational amplifier circuits.

5) Fourier series.

6) Locus ^{diagram} of variable frequency circuits.

7) Analysis of electric circuits with non sinusoidal AC supply.

~~Prerequisite~~ (Pre-requisite) circuit 1 - DE

Skills:

① Curve tracing.

② Programming

③ Matlab

Ch. 5 The operational amplifier

Ch. 6 Inductance Capacitance Mutual inductance

Ch. 7 Response of 1st order circuits RL & RC circuits

Ch. 8 Natural & step response of RLC circuits

Ch. 11 Balanced three phase circuits

Ch. 16 Fourier series

Transient analysis

Rev on ODE

* ind variable

Time
 t

states

* dep variables

$x \rightarrow x' \quad x'' \dots x^{(n)}$
 $y \rightarrow y' \quad y'' \dots y^{(n)}$

* Forcing function $f(t)$

Types of ODE

Linear DE with const coeffs



$$a_n x^{(n)} + a_{n-1} x^{(n-1)} + \dots + a_1 x' + a_0 x = f(t)$$
 كل متغير مشتق
 قبل معاملات

2 Linear DE with time varying

یہی DE کا معنی ہے کہ DE میں متغیرات

of line

a_0 or a_1 or a_n

3 Non linear Diff eqⁿ :-

as $a_1 \sin x''$

$a_2 x'^2$

$a_3 \sqrt{x''}$

$x'' x'$

Non linear system

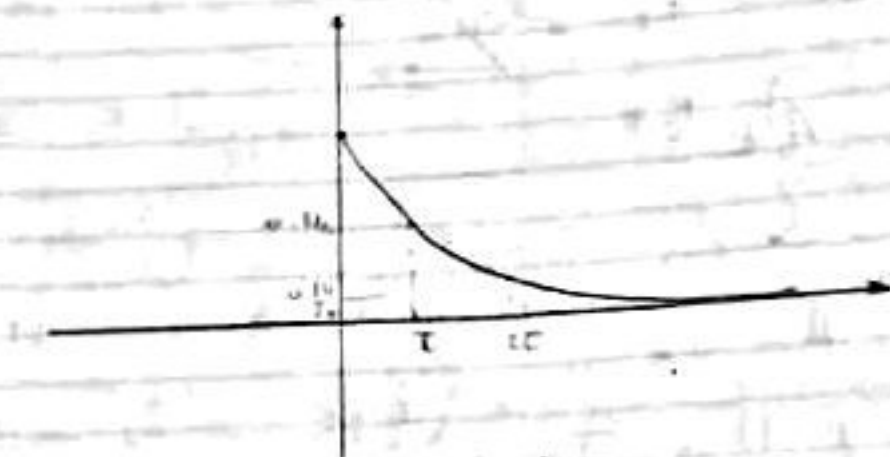
Response obtain $x(t)$

Types of circuit elements active, passive



$$i(t) = I_0 e^{-t/\tau}$$

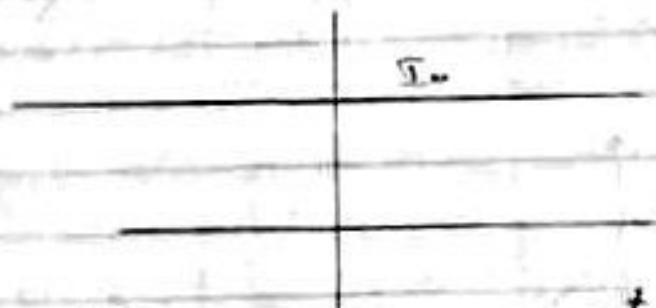
t	0	τ	2τ	3τ	4τ	5τ
i(t)	I_0	$0.37 I_0$	$0.14 I_0$			



5T steady state V current
L, R value τ time

In super conductor $R \rightarrow 0$

$$\tau \rightarrow \infty$$



$$V = Ri = I_0 R e^{-t/\tau}$$

$$V = [I_0 R] e^{-t/\tau} \rightarrow V_0 \text{ initial condition}$$

DC	R	L	C
V	iR	0	-
i	$\frac{V}{R}$	$\frac{V}{L}$	0

AC	iR	iX_L	iX_C
	$\frac{V}{R}$	$\frac{V}{X_L}$	$\frac{V}{X_C}$

Transient and Steady R



L C

Steady

$V = V_0 + \frac{1}{L} \int i dt$ (for L)
 $i = \frac{1}{L} \int v dt + I_0$ (for L)
 $V = \frac{1}{C} \int i dt + V_0$ (for C)
 $i = C \frac{dv}{dt}$ (for C)

Note: $\frac{1}{L} \int i dt$ is the integral of current over time, which is the change in flux linkage.

inductive R-L pure inductive L

Natural Response of RL Circuits

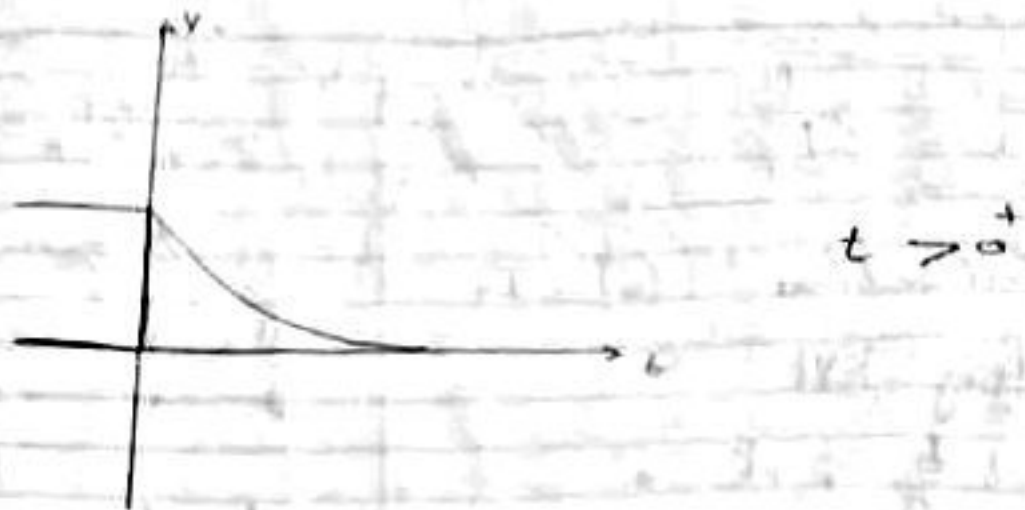
initial condition



$$i(0) = I_0$$

Forcing function supply voltage

initial condition



$$C \frac{dv}{dt} + \frac{1}{R} v = 0$$



$$v(t) = A e^{-t/\tau}$$

From I c

$$i(0) = V_0 = A$$

$$i(t) = V_0 e^{-t/\tau}$$

τ Time $\rightarrow RC$

$$L \frac{di}{dt} + Ri = 0$$

يسمى مثل هذه المعادلات معادلات $\frac{di}{dt}$ (homogeneous)

$$\frac{di}{dt} + \frac{R}{L} i = 0$$

$$i = i_c + i_s \dots$$

$$i_c = A e^{-\frac{R}{L} t}$$

from initial condition
 $i(0) = I_0 = A$

$$A = I_0$$

$$i(t) = I_0 e^{-\left(\frac{R}{L}\right)t}$$

$$\tau : \text{time const} \rightarrow \frac{L}{R}$$

$$i(t) = I_0 e^{-t/\tau} \quad t \gg 0$$

$t \rightarrow \infty \quad i = 0$

inductor resists the inst change in current

Capacitor " " " " " in voltage

